



# Joint analysis of galaxy imaging for photometric redshift assignments in the WFIRST-AFTA lensing survey

WPS Meeting  
2016-03-03

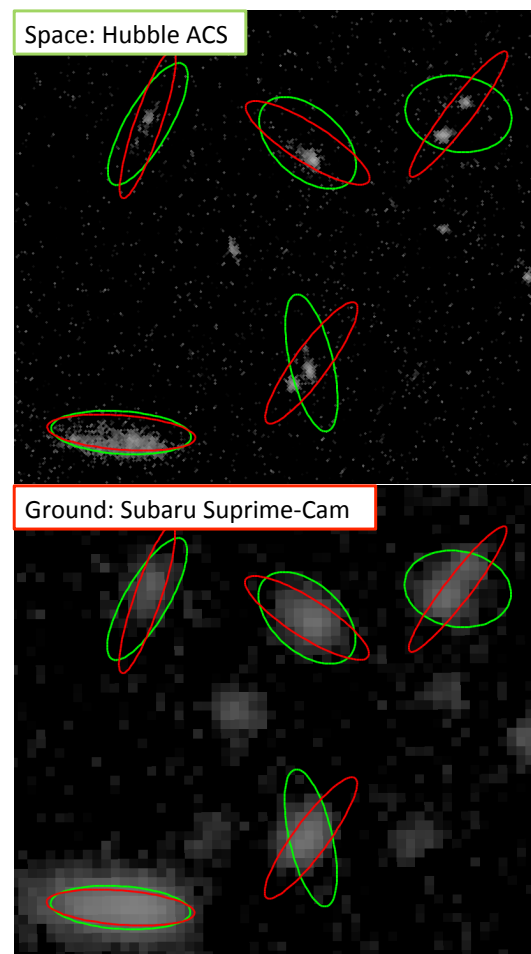
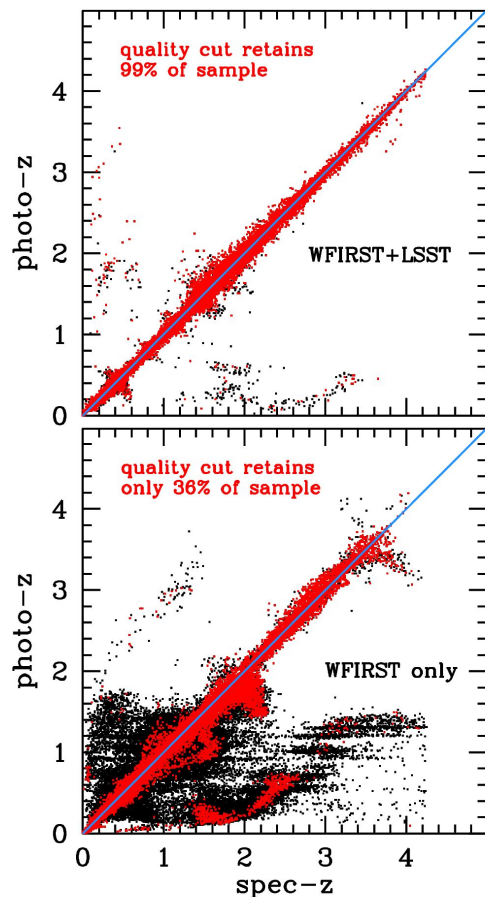
Michael D. Schneider (LLNL)

Team:

W. Dawson, G. Dubois-Felsman, D. Lang,  
R. Mandelbaum, J. Meyers, J. Rhodes, S. Schmidt, T. Tyson



*The problem:* We need LSST photometry for good photo-z's, but there's an ambiguity in cross-matching sources caused by blending



Note: Still need photo-z's as a first step in calibration via spec-z cross-correlations



# Objectives & Milestones

- **Objectives**

1. Characterize photo-z failures of non-deblended LSST galaxies (frequency & properties)
2. Identify merits/drawbacks of forced photometry of LSST given WFIRST images to mitigate blending-induced systematic errors
3. Develop & validate joint pixel modeling algorithm to improve photo-z inferences and assignments to WFIRST sources
4. Develop statistical training algorithms to improve LSST photo-z's in survey regions not overlapping WFIRST HLS

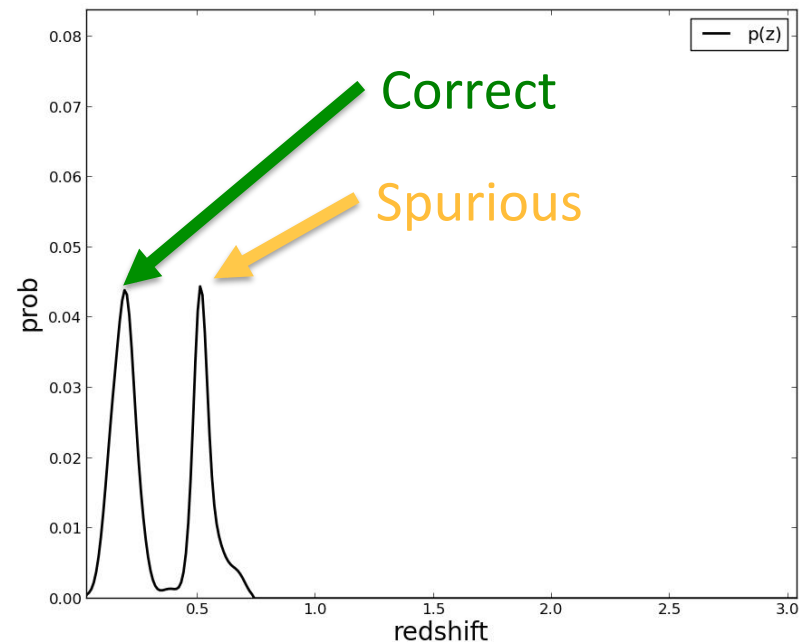
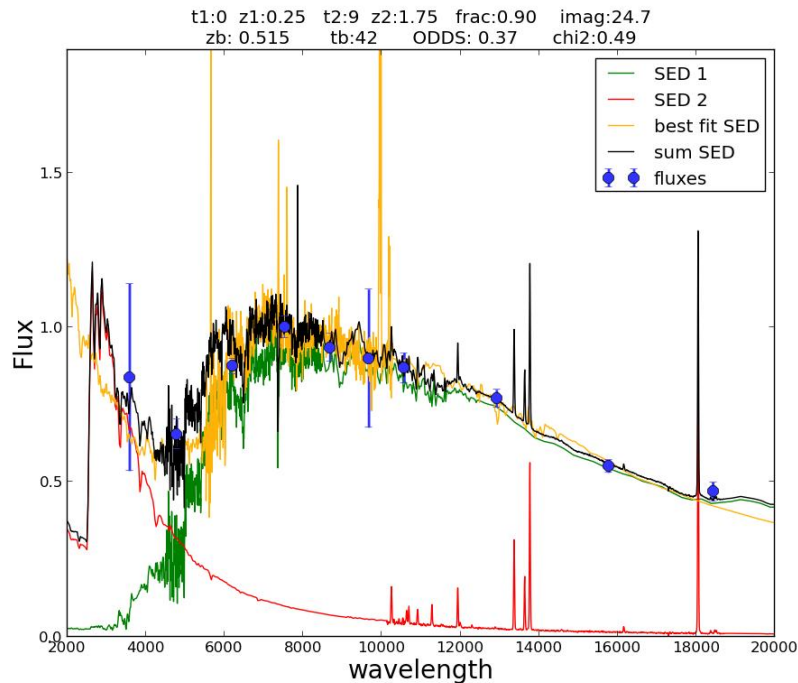
- **Milestones**

1. [02/16] Build image simulations of blends as seen from LSST & WFIRST (closed)
2. [05/16] Characterize photo-z failure modes for blended LSST images
3. [12/15] Develop likelihood framework for blend analysis (overdue)
4. [09/15] Joint fit galaxy models to LSST & WFIRST simulated images
5. [03/17] Report photo-z inference performance with joint fitting algorithms
6. [05/17] Report LSST impacts of improved photo-z's



## Example: Photo-z failure for a blended pair of galaxies

Often, the composite spectrum of 2 overlapping objects is mistaken for the spectrum of a different type of object at a different redshift.



*i*-band

90% flux:  $z = 0.25$  elliptical

10% flux:  $z = 1.75$  starburst

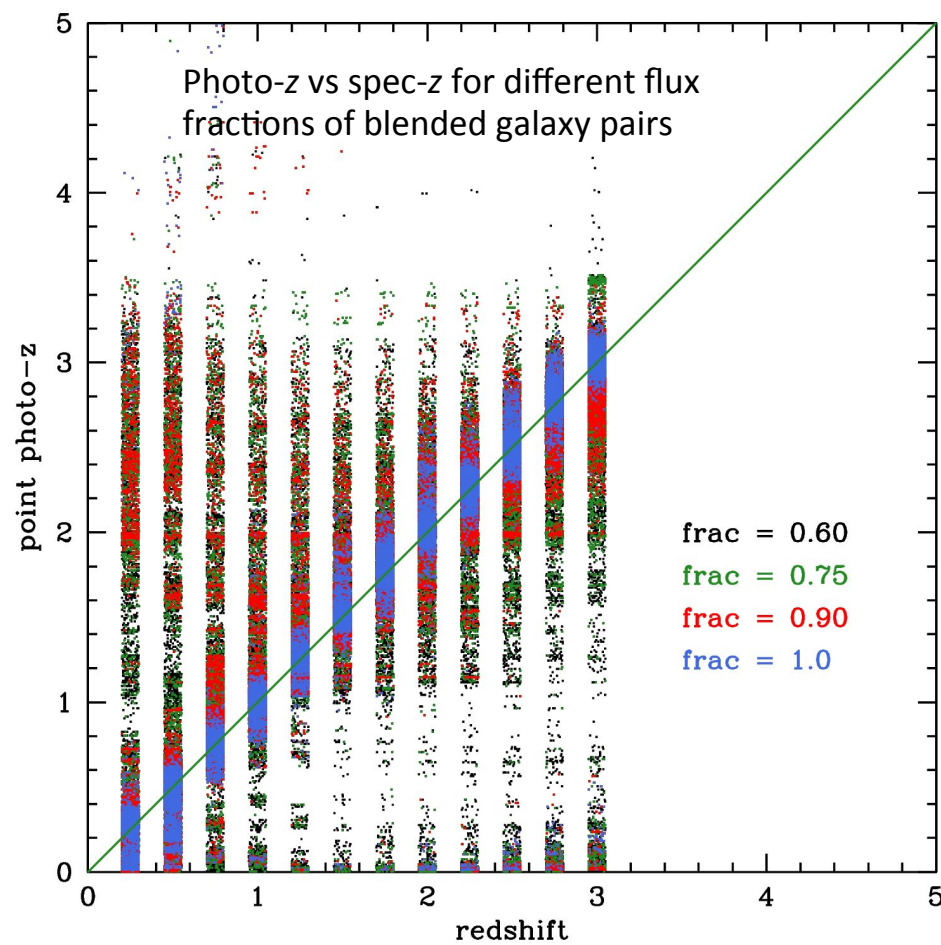
Confused with  $z \sim 0.5$  spiral

Get the correct low- $z$  result with  $\sim 50\%$  probability.  
The high- $z$  starburst galaxy is “lost”.



# Grid search: What combinations redshifts, relative fluxes, spectra give photo-z failures?

- Galaxy pair flux fractions from 0.6 – 1.0, where 1.0 indicates a single galaxy without any blending
- Simulations on a grid of:
  - Pair redshift separation
  - SNR
  - Spectral types
- Photo-z estimates use 10 bands:
  - 6 LSST + 4 WFIRST

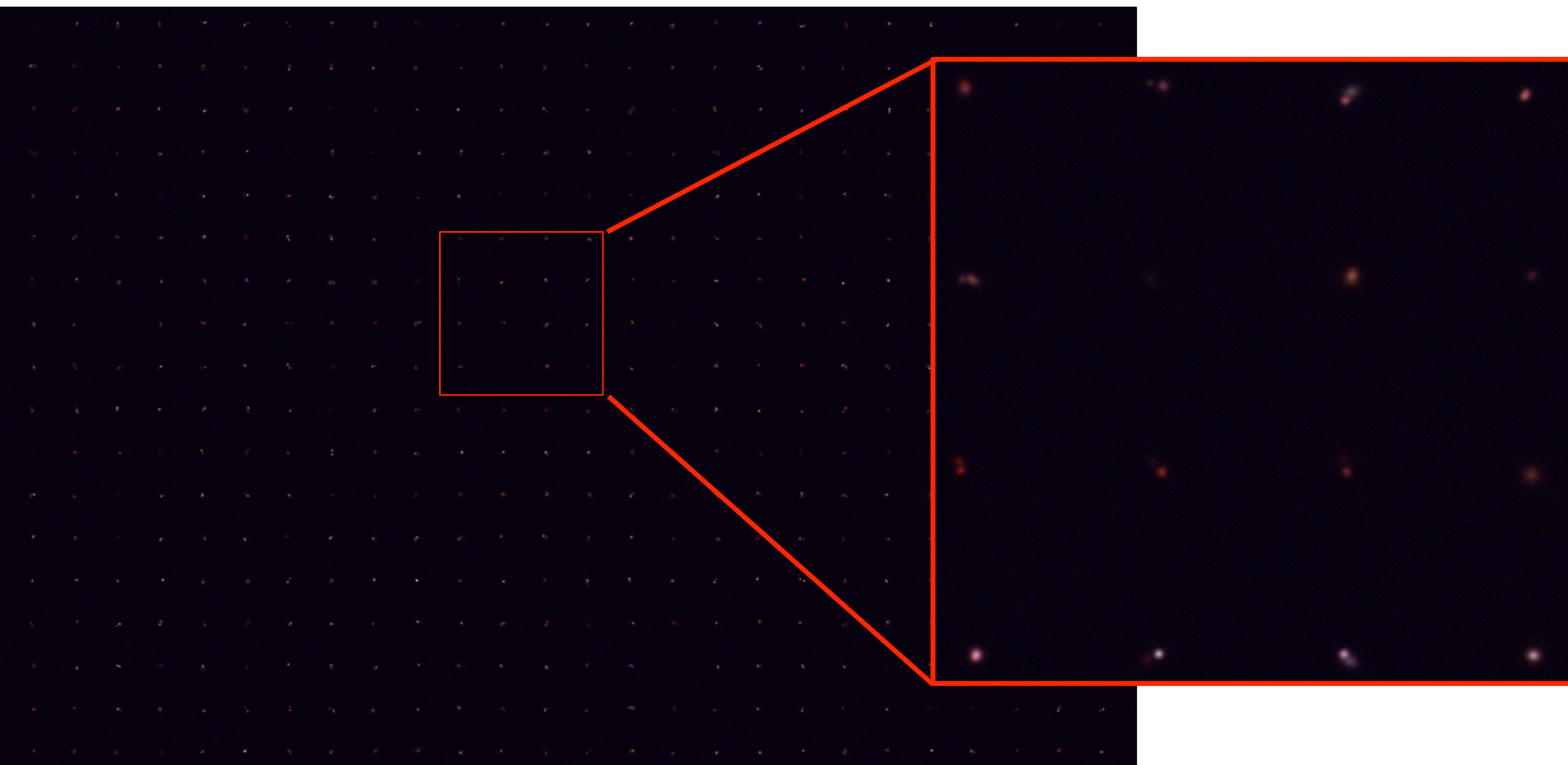






# Grid search: Image simulations with varying galaxy pair impact parameters, relative fluxes, spectral types

Sizes, ellipticities, & redshifts from LSST CatSim (based on cosmology simulation)



Download: [https://github.com/mdschneider/wfirst\\_photoz/wiki/Blend-simulations](https://github.com/mdschneider/wfirst_photoz/wiki/Blend-simulations)



# Features of blend simulations

- GalSim WFIRST module
  - Bandpasses
  - Noise (incl. detector, sky background)
  - WCS – sensor array
  - Aberrated PSFs
- GalSim LSST module - under development
  - Bandpasses
  - Simple noise model
  - PSFs (atmosphere + aberrated optics)
- LSST CatSim galaxy catalog
  - Millennium light-cone & De Lucia+ semi-analytic galaxies
  - SEDs from Bruzual & Charlot models
  - Disk & bulge components (implying early/late types)
  - We use *z*, mags, sizes, ellipticities – but not positions – from the catalog
- Consistent colors using Brown+2013 SED templates rendered through the bandpasses



Example: deblended with LSST imaging, but significant flux contamination from neighbor







# Example: not deblended with LSST imaging alone



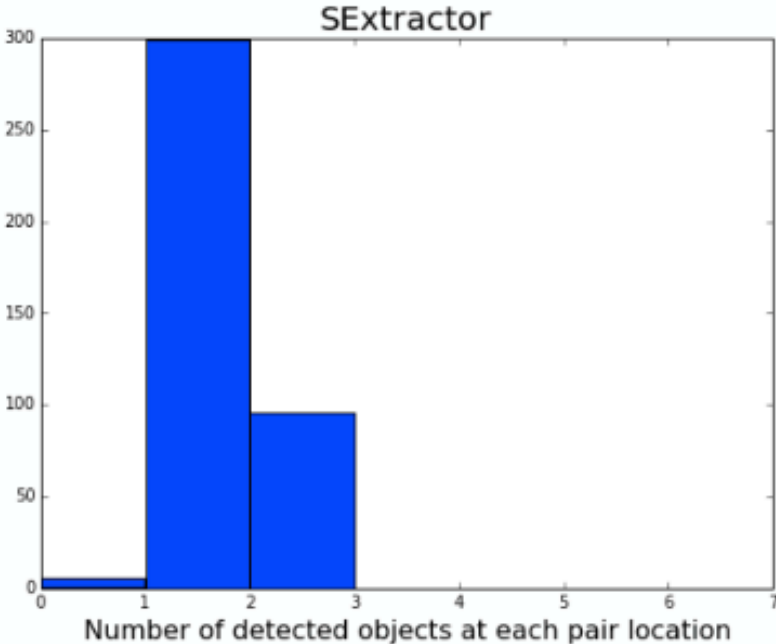
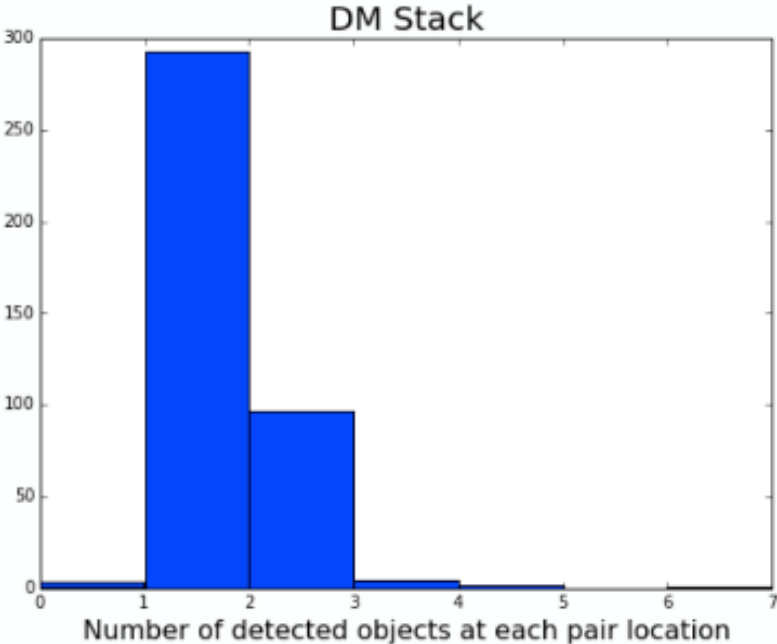
Next steps:

1. Analyze photo-z estimates for all galaxy pair images.
2. Use WFIRST detection band (i.e., forced photometry) and repeat.



# Deblending and photometry with LSST Data Management stack

## 1D histogram of detected objects



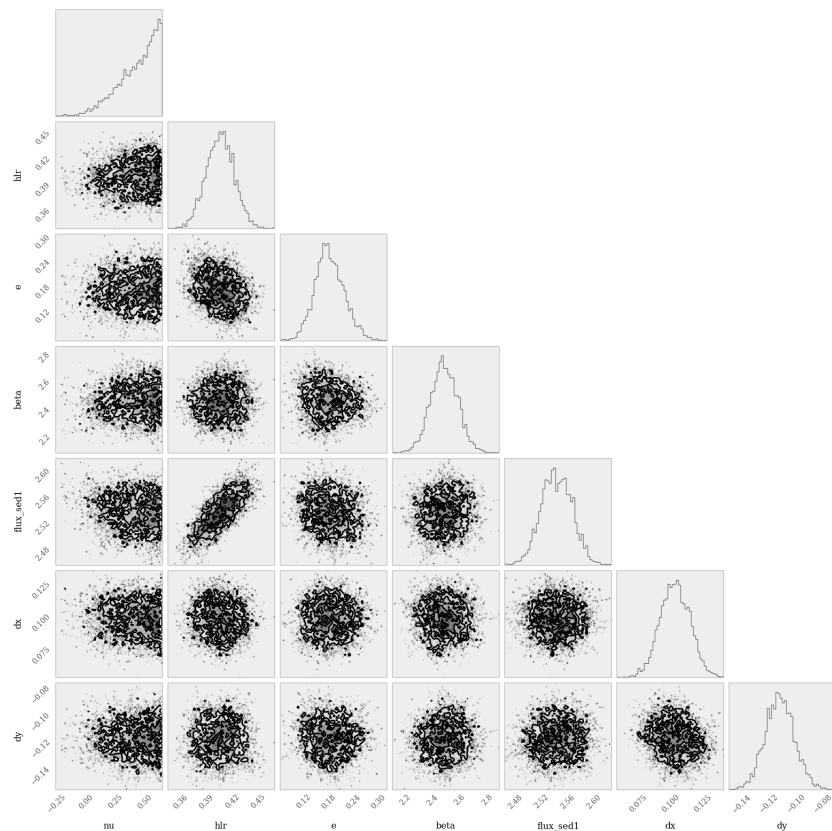
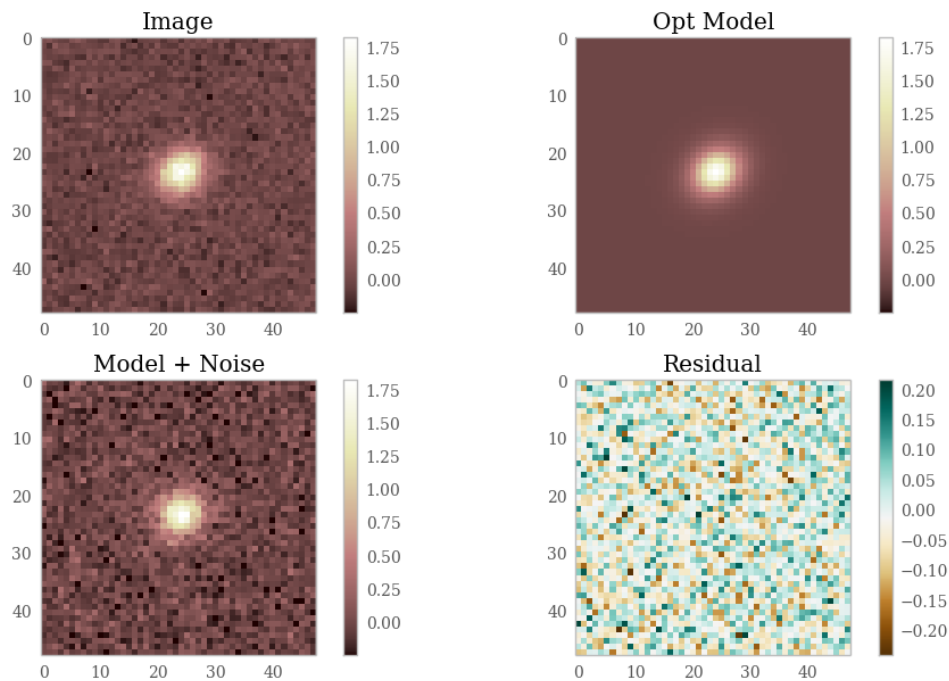
3 (1%): failed detections  
293 (73%): failed deblend identification  
97 (24%): correctly deblend  
7 (2%): deblended too many sources

5 (1%): failed detections  
295 (75%): failed deblend identification  
96 (24%): correctly deblend  
0 (0%): deblended too many sources

Preliminary



# We can fit these galaxy images using GalSim embedded in a Monte Carlo framework



Next steps:

1. Validate model fitting of blend pairs
2. Process all gridded blend images through Monte Carlo pipeline
3. Explore probabilistic redshift assignments for WFIRST galaxies



# Milestone 1: blend simulations

Our work is available via Github 'Issues' and 'Wiki' to other WPS teams.

## Task 1: Build image simulations

Closed 9 minutes ago ⌚ Last updated 7 minutes ago

Simulate galaxy observations from LSST and WFIRST including distributions of blended sources. This Milestone requires a software pipeline wrapping GalSim (and maybe PhoSim) for generating a library of blended images to be analyzed for photometry and photo-z estimates.

100% complete 0 open 4 closed

[Edit](#) [Reopen](#) [Delete](#)

4 issues with team commentary and code updates led to progress on our first milestone.

## Blend simulations

Michael D. Schneider edited this page 5 days ago · 18 revisions

We're using the CatSim catalog compiled by D. Kirkby [available here](#) and compiled for the [WeakLensingDeblending](#) DESC project.

The images are rendered with GalSim, including our wrapper scripts for handling the multiple objects, chromaticity, and multiple bands / telescopes.